

# NUTRIENT CONTROL STANDARDS WORKSHOP

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## Summary Report

prepared by the

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HEARING Nutrients-WQS Amendmen~  
& Policy, Newport News, Roanoke,  
and , Spotsylvania;

## Introduction

In 1985 the Virginia General Assembly established, a joint subcommittee to examine nutrient enrichment problems in Virginia's portion of the Chesapeake Bay. The committee recommended the Virginia Water Control Board (VWCB) develop:

water quality standards to protect the Bay and its tributaries from nutrient enrichment; and

strategies to implement those standards.

The legislature directed the VWCB to do so by June 1986, and in the fall of 1986 the VWCB appointed a Technical Advisory Committee (TAC) to assist them. (A membership list is attached.)

There were a number of specific issues the Board wanted advice on prior to developing these standards:

1. Should the state develop narrative or numerical standards or both? A number of states have only narrative standards, others use a combination. At present Virginia has a general narrative standard with reference to nutrient related problems, but has no specific nutrient standards or criteria.
2. What are the most appropriate parameter(s) for nutrient control standards? States with numerical standards have used a variety of parameters including total phosphorus, nitrogen (or its toxic versions nitrate, nitrite, ammonia), chlorophyll a, dissolved oxygen, and others. (Virginia is currently developing separate standards for toxics.)
3. What are the appropriate numerical levels for standards? Most states recognize that numerical nutrient standards must be set in ways that allow for differences in water body types and background conditions.
4. What are the appropriate monitoring, sampling, and evaluation methods? Monitoring frequency and method, and whether compliance should be determined based on seasonable averages, one time exceedence, etc. are all part of an effective strategy.



5. What should be done about a variety of other issues related to effective implementation of the standards? These include but are not limited to: ways to address non-point source problems, where resources should be directed for greater effectiveness, and what data and research priorities should be.

Prior to this workshop members completed two rounds of a Delphi questionnaire process in which they expressed preliminary views on the questions listed above. The workshop, facilitated by staff from the Institute for Environmental Negotiation, was designed to build on the Delphi process and develop as much consensus as possible among these experts on issues related to developing nutrient control standards. This report summarizes the major recommendations of the committee and the rationales behind them. .

### **Overall Approach.**

As a first step in developing standards to protect state waters from nutrient enrichment the Water Control Board has to select an overall approach or type of standard (narrative or numerical, instream or effluent, statewide or by water body type or basin) that will serve as the basis for future control strategies. In the two Delphi Questionnaires completed by TAC members prior to the workshop, a majority of the group favored:

- a ) a combination of narrative and numerical standards;
- b) instream standards; and
- c) standards by water body types, i.e., lakes, estuaries, etc.

In discussing the overall approach during the workshop, TAC members raised a number of issues, most of which revolved around the question of whether the state should establish instream or effluent standards or both.

### **Instream vs. Effluent Standards**

Members began by clarifying the distinction between instream and effluent standards: instream standards refer to numerical limits for certain parameters as measured in the water body; effluent standards refer to uniform limits on the discharge of certain constituents by all point sources; permit limits refer to the restrictions placed in a permit on



the constituents in an effluent discharge by a point source. There is an obvious link between achieving instream standards and regulating point source discharges through effluent standards, permits, or some combination of the two.

It was suggested that an instream standard was the best way to maintain water quality and provide a sound basis for a nutrient management program consistent with a state policy of protecting all beneficial uses. With an instream standard approach, when monitoring shows the standard has been exceeded, this becomes a trigger for further analysis waste load allocation modeling, and management programs that place limits and requirements on both point and non-point sources. Effective implementation of an instream standard requires careful analysis of cause and effect relationships between the nutrient problem as identified by the 'trigger,' and various potential sources. It also requires identification of the appropriate management area, i.e., how far back up stream one should go in assigning wasteload allocations. It was suggested a "test of reasonableness" was the best way to approach this, including all areas and discharges "reasonably" closely connected with the problem.

While all members agreed instream standards were necessary, some thought they should be accompanied by statewide effluent standards as well. Effluent standards alone provide no way to address non-point sources. This problem is overcome, however, if effluent standards are used in conjunction with an instream standard.

Proponents of statewide effluent standards -argued that such standard His are easy to administer and enforce, can be implemented inexpensively (in the case of biological removal of phosphorus) and provide direct immediate reduction in total nutrient load. Arguments offered against such standards were that requiring across the board nutrient removal even in places where nutrient enrichment is not a problem places a burden on industries and municipalities with no commensurate benefit to water quality. It was also suggested that uniform effluent standards with a limited scientific basis in instream quality might be challenged in court.

### **Other issues**

Members said narrative and numerical standards are both needed because they serve different functions. Narrative standards provide an overall statement prohibiting actions that degrade water quality and give the state discretion in doing what is needed to protect the resource. They

cover all the situations that cannot be fully anticipated and defined and can allow for regional differences. Numerical standards, on the other hand: set specific limits that serve as the basis for point and non-point source regulation.

Some TAC members questioned whether Virginia could set water quality standards without setting certain goals or use classifications for various waters. Virginia's anti-degradation policy prevents classification of waters as a basis for differential protection; the waters of the state must be protected to allow for all beneficial uses. It is, however, possible to set standards by water body type or, geographic region where there is a scientific basis for this. It was pointed out that to develop attainable standards the state will have to take account of background levels of nutrients and the geo-chemical factors affecting these in the various regions and waters of the state.

**Recommendation: Virginia should adopt a combination of narrative and numerical nutrient standards. The numerical standards should be statewide instream standards developed for specific water body types such as. lakes, rivers, and estuaries. The narrative portion of the standard should contain general language on protecting all waters from nutrient enrichment and acknowledge the need to allow some regional variation in standards if naturally occurring differences in nutrient levels justify this.**

### **Water Quality Parameters**

in the Delphi questionnaires completed by TAC members, six parameters received the most support as candidates for nutrient control standards: chlorophyll a; dissolved oxygen maximum and minimum; total phosphorus; inorganic nitrogen; orthophosphorus; and total nitrogen..

As a first step in refining this list at the workshop, TAC members were asked to select the parameter(s) they considered most appropriate for a nutrient control standard. Inorganic nitrogen and orthophosphorus received no support and were eliminated from the list. In discussing the w remaining four parameters, advantages and disadvantages were identified.

### **Chlorophyll a**

The major advantage of chlorophyll a is that since it reflects the amount of plant material in the water, it is the best measure of an actual eutrophication problem. High chlorophyll a levels signal that there is a problem, making it an excellent standard to "trigger" nutrient management programs.

Disadvantages of chlorophyll a are that it only measures the consequences of nutrient enrichment, i. e., eutrophication. It is possible to have fairly high nutrient levels without a lot of algal growth. Because of the nutrient transport phenomenon, chlorophyll a problems may manifest themselves at some distance from upstream loading, making appropriate assignment of responsibility difficult. Also, the level of chlorophyll a in water may vary as a result of turbidity, stream flow, and other factors unrelated to nutrient levels. Chlorophyll a can be difficult to sample because it is not evenly dispersed and usual sampling methods would not measure the amount of macrophytic or periphytic plant life.

### **Dissolved Oxygen**

The standard proposed for dissolved oxygen was maximum/minimum values over a 24-hour period ( ) D.O.) ) D.O. is directly related to the health of fish and plant populations and the overall productivity of waters and is affected by both algal and macrophytic growth. The primary cause of dissolved oxygen variation is the photosynthesis process connected with plant growth and for this reason it is a very good indicator of eutrophic conditions. ,

Disadvantages include the fact that D.O. variation is a consequence of eutrophication and therefore even further removed from actual nutrient levels than chlorophyll a. Variation in dissolved oxygen levels in different water body types was also suggested as a problem and D.O. can be affected by turbidity and natural aeration as well as organic loading.

### **Total Phosphorus and Total Nitrogen**

TAC members discussed total phosphorus and total nitrogen simultaneously as possible standards. The major advantages of using TN and TP are that this ties the standard directly to the underlying cause of the eutrophication problem -excess nutrients. When TP and/or TN



standards are exceeded no cause and effect relationships have to be established before going directly to management strategies (although relative shares and waste load allocations must still be developed). Using TN and TP also provides a way to address upstream nutrient transport.

The disadvantages of TP and TN are that it is possible to have high levels of nutrients in certain bodies of water without having excess algal growth. Different levels cause different problems in different bodies of water. While these may ultimately cause problems downstream they do not cause any immediate problems and it may not be necessary to take any action.

### General Discussion

In considering the various parameters, considerable discussion revolved around whether one should use the causes of eutrophication (TN, TP) or the symptoms (algal growth as represented by chlorophyll *a*, and ) D.O.) as the standard. In the case of the latter, the standard would be exceeded only when an actual eutrophication problem exists. They would serve as a trigger for follow-up monitoring and initiation of management strategies. Use of the nutrients themselves as standards on the other hand is directed toward reducing overall nutrient loading and can be more easily tied to various point and non-point source discharges. Enforcement problems could arise with either approach. In the case of chlorophyll *a* and ) D.O. it may be difficult to tie the problem to specific discharges. In the case of TN and TP, the state could be left trying to enforce a standard when no observable water quality problem exists.

**Recommendation: Chlorophyll *a*, ) D.O., TN and TP are all possible parameters to use as nutrient standards. While using all four would be most desirable it is probably not practical or necessary. The most appropriate parameters) should be selected for each basic water body type.**

### **Standards for Specific Water Body Types**

To develop recommendations regarding parameters, numerical values and sampling techniques for specific water body types, the TAC members divided into two groups: One group considered standards for freshwater lakes and flowing waters. The other group considered standards for estuaries and tidal fresh waters.



## **Freshwater Lakes**

Each of the four parameters was considered to develop a recommendation for fresh water lakes.

Chlorophyll a: Most members favored use of a chlorophyll a standard for lakes. A numerical level of 25 : g/l as a monthly average with a maximum one time exceedence level of 50 : g/l was proposed. These values received general support from the group. (here was discussion about whether the chlorophyll standards should be based on planktonic chlorophyll only or same consideration given to macrophytic chlorophyll as well. It was determined that a planktonic measure would be easier to sample and would accurately reflect the eutrophic condition' of the lake.

It was suggested that monitoring samples be taken at 1/2 the Secchi depth as long as that depth was greater than one foot. An alternative proposal was to use an integrated mixed layer sample which some members argued would yield more reliable results. The use of Secchi depth is, however, a well-recognized and reliable method and it was favored for its simplicity.

Group members thought the numerical chlorophyll standard should be combined with a narrative element that would deal with the problems caused by high chlorophyll levels: taste, odor, and clogged filters at water treatment plants.

Dissolved Oxygen: It was the consensus of the group that due to wide variation in D.O. at different depths and the difficulty this creates in setting standards and sampling techniques and the fact that D.O. problems are symptoms which would be reflected in other standards, no standard for D.O. should be recommended. The group did agree that a narrative component addressing the conditions associated with D.O. problems should be drafted.

Total Phosphorus: The group suggested two possible standards for total phosphorus in lake waters. A level of 50 : g/l as a weighted mean based on the water mass, or a level of 25 : g/l as a mixed layer mean. These levels were judged to be of equal validity as a measure of total P. (it was noted that if chlorophyll were sampled on a mixed layer basis this might be the favored approach since the two samples could be taken at the same time.)

Total Nitrogen The group discussed the possibility of linking the standard for total nitrogen to the standard for phosphorus. It was suggested that some N to P ratio could be used or that the nitrogen standard could be set at ten times the phosphorus standard. After discussion, the group agreed that no nitrogen standard should be set. Phosphorus is almost always the limiting factor in the eutrophication of Virginia's warm water lakes and the group thought a nitrogen standard would be unnecessary.

**Recommendation: In freshwater lakes the state should consider setting a chlorophyll a standard of 25 : g/l as a monthly average, with a one-time exceedence level of 50 : g/l with both measured at 1/2 the Secchi Depth (if > 1 foot). This should be combined with a total phosphorus standard of 50 : g/l as a weighted mean or 25 : g/l as a mixed layer mean. A narrative component should be developed as well to address more general chlorophyll a and D.O. problems in lakes.**

#### Flowing Waters

In considering each of the four parameters as standards for flowing waters, the group concentrated on the special characteristics of stream environments.

Chlorophyll a: In discussing chlorophyll a, members focused on the need to develop a standard that would take account of macrophytes and periphyton -- the major types of plant growth found in flowing waters. The group discussed the differences in stream type and the need for different sampling methods for chlorophyll. It was suggested that a chlorophyll standard for streams would require at least two sub-categories of flowing water: low order streams and high order streams.

After considering the advantages and disadvantages of a chlorophyll standard for flowing water, the group concluded that no numerical standard should be used. A narrative standard was recommended to be phrased in terms of the amount of plant coverage of the stream bottom: "Visible growth of green plants on 40% of the wetted perimeter of the stream bottom." Such a standard would take account of macrophytic vegetation without requiring a different standard for differing stream types. The suggested figure of 40% was recognized as a rough approximation only. Some other percentage might be substituted after more careful consideration.

Dissolved oxygen: The group agreed that dissolved oxygen in streams is also affected by stream type. Therefore, rather than setting precise numbers for a D.O. standard, it was suggested that the standard be related to the oxygen saturation value of the water in question. The standard would be violated by a fluctuation over 24 hours greater than 1/3 of the oxygen saturation value. (again, the 1/3 value was a suggested figure which might need to be modified in actually setting the standard.) Relating the standard to the oxygen saturation value would avoid the need for altering the standard for different stream types while reflecting the wide fluctuations characteristic of dissolved oxygen problems.

Total Phosphorus: In considering a phosphorus standard for flowing water, the group agreed that in some regions of Virginia, a significant amount of the phosphorus in streams comes from natural sources. Given this divergence in background levels for streams, the group suggested a range of values for the phosphorus standard from 100 to 200 : g/l, depending on the natural background levels of phosphorus in the region.

Total Nitrogen: The group agreed that no standard for nitrogen in flowing waters was necessary.

**Recommendation: The water quality standards for flowing waters should be a 24 hour dissolved oxygen fluctuation of less than 1/3 of the oxygen saturation value (with the 1/3 to be tested/refined; a TP range between 100 and 200 : g/l depending on established background conditions; and a narrative standard 'visible growth of green plants on 40X (with the 40% to be tested/refined) of the wetted perimeter of the stream bottom.'**

### **Tidal Waters**

The second sub-group considered tidal waters: estuaries and tidal fresh, and the appropriateness of the four parameters for those water body types. In discussing the first parameter, chlorophyll *a*, a number of strategic issues were addressed that have implications for the other parameters as well.

Chlorophyll a: Members thought it was essential to establish a reference point from which an appropriate chlorophyll a standard could be developed. To do this they first made a distinction between stressed and unstressed waters. For unstressed waters, it was suggested that background levels be the point of reference and that the standard be .3 function in excess of background. For stressed waters a point of reference other than current conditions would be needed since restoration rather than non-degradation would be the state's environmental objective. It was implied that a common understanding of "stressed" was in the participants minds - at least in the narrative sense that stress could be recognized based on certain observations.

The problems inherent in defining the concept "background" (i.e., how far back in time or distance it is necessary to go in order to establish the background condition, or how to interpret naturally occurring conditions that exceed contemplated standards) were pointed out by several participants. For unstressed bodies, a working definition based on available data was suggested. This would reflect average conditions not associated with signs of stress. Based on familiarity with the Potomac it was suggested that this point of reference might be 50 : g/l Another participant noted that this number would mean that only the James would be out of compliance. Following the suggestion that establishing a reference point is primarily an empirical question, a logical next step would be to do this by examining and interpreting existing data.

A number of suggestions were made about the function that would relate the standard to this reference point. These included 20% above background, one or two standard deviations above background, or some other form of probability distribution. A final suggestion was a standard of 20% above background which should not be exceeded by more than 30%, 95% of the time.

If examination of the available data showed relatively little variation in background levels among water bodies of a particular type, a tabular presentation of the standard could be developed once these background levels had been established and the appropriate function agreed upon.

The following was suggested as an example of background chlorophyll a numerical values that might be found upon examination of background data.

	:	—
tidal rivers	20	10
estuaries	10	2
embayments	50	25

Such a table could then be used to establish standards as some function of these background conditions. As a remediation target stressed bodies could be restored to the standards established for unstressed bodies.

Dissolved Oxygen: The group discussed the relationship between diurnal dissolved oxygen fluctuation and chlorophyll levels in estuaries ,and tidal fresh waters. They agreed that background chlorophyll levels would affect dissolved oxygen levels and therefore the ) D.O. standard could be related to background chlorophyll as well. The group also considered using a ) D.O. standard relating D.O. fluctuation to a percentage of the maximum saturation value, or setting only a maximum D.O. level. The consensus was that the best approach would be to assess background chlorophyll levels and set ) D.O. standards from them.

Total Phosphorus and Total Nitrogen: It was-generally agreed that phosphorus and nitrogen are good indicators of potential eutrophication problems.

Considerable discussion took place about measuring TP/TN in surficial sediments as well as in transport. There was agreement that TP/TN would be important factors in remediation efforts and in nutrient load allocation strategies but there continued to be division within the group about including total phosphorus and total nitrogen in the standard.

To get a better sense of opinion a straw poll was taken with the following results:

<u>Options</u>	<u>Supporters</u>
(A) Chi- a and , & DO standards (TN/TP monitored only)	9
(8) Chl a, ) DO, TN/TP standards	1
(C) TN/TP (sediments) standards	2

**Recommendation: Chlorophyll a and ) D.O. should be used as the standards for estuaries and tidal fresh waters, supplemented by monitoring for TN and TP. The chlorophyll standard should be expressed as some function of background chlorophyll a levels. The ) D.O. standard should also be developed relative to background chlorophyll a levels.**

Summary of Proposed Standards by  
Water Body Type

	<u>Freshwater Lakes</u>	<u>Flowing Waters</u>	<u>Estuaries</u>	<u>Tidal Fresh</u>
Chlorophyll a	25 : g/l monthly average 50 : g/l one time maximum	Narrative Stnd. only	120% (or other function) of Background	120% (or other function) of Background
Dissolved Oxygen	Narrative Stnd. Only	24 Hour Fluc- tuation < 1/3 Oxygen Satur- ation	Stnd. Related to Background Chlorophyll	Stnd. Related to Background Chlorophyll
Total Phosphorus	50 : g/l	100: g/l to 200 : g/l Allowing Regional Variation	No Standard; Monitoring Only	No Standard; Monitoring Only
Total Nitrogen	No Standard Monitoring Only	No Standard Monitoring Only	No Standard Monitoring Only	No Standard Monitoring Only

**Content of the Narrative Standard**

In the closing discussion of the workshop, TAC members were asked to consider the role of narrative standards in controlling eutrophication. Virginia's existing narrative standard, which emphasizes preserving beneficial uses and limiting common eutrophication problems (taste, odor, and nuisance aquatic plants) was compared to North Carolina's approach to narrative nutrient standards. North Carolina has defined a special classification of 'nutrient sensitive waters' where special controls on



nutrient enrichment may be imposed unless such controls would cause economic hardship. The North Carolina example raised several issues for discussion.

TAC members agreed on the value of narrative standards - major changes can occur in a waterbody which may not be reflected in the parameters chosen as standards. These changes may require intervention and management to prevent future problems. Narrative standards can provide the basis for this including allowing the Board to designate special nutrient management areas when necessary.

There was considerable discussion of the use of economic hardship as a justification for allowing nutrient standards to be violated. TAC members noted that if an economically depressed area were allowed to exceed established nutrient standards, nutrients could be transported downstream and cause eutrophication problems far from the site of the economic hardship. Such a situation might, in fact, pose hardship on downstream uses of water, depending on the effects. Determining whose economic hardship should control the situation would not be an easy task; and from a scientific standpoint, a significant gap in a nutrient management strategy could frustrate an entire program.

**Recommendation: The state should develop a narrative nutrient standard that permits the state to give special attention or consideration to problem areas including some classification such as 'nutrient management area' if this is deemed necessary.**

## **Elements in an Effective Nutrient Control Strategy**

During an informal evening Roundtable session TAC members discussed a number of issues and concerns related to establishing an effective nutrient control strategy.

### **Non-Point Source Issues**

A majority of the issues raised dealt with non-point source contributions to eutrophication problems and some of the ways to manage them. It was suggested that one of the reasons non-point sources are so hard to control is that the negative water quality effects often occur at a great distance from the non-point inputs making it hard for people to recognize their responsibility. This creates a situation like the "Tragedy of the Commons" problem in land use where the cumulative effect of individual decisions that by themselves are not harmful can destroy a common resource.

The differences between voluntary and mandatory non-point source controls were discussed. Voluntary BMP's have been helpful in reducing non-point source pollution, but not all owners and local governments participate and when ownership or management changes, BMP's may be neglected. Maryland has a non-point source program in which mandatory regulations based on a narrative standard back up their voluntary BMP program. Other innovative approaches to non-point source management that were mentioned included a "pollution trading" approach being used in Denver and various non-point source demonstration projects undertaken by the T.V.A.

TAC members discussed the cost of non-point source pollution control. The Water Control Board is required to consider economic impacts in the standard development process. It was suggested the best way to handle this is to have a standard that directs nutrient control management efforts where they are most needed. Using this approach, a significant problem is identified through some "trigger." Nutrient controls are then linked to watershed loading allocations for all the sources within that watershed. While relative shares of non-point source pollution can be difficult to determine, members suggested the use of existing knowledge/data combined with aerial photographs provides one reasonable approach. An alternative to developing wasteload allocations throughout the watershed of a stressed lake would be to undertake lake restoration at

the site. A major problem with this approach is deciding who should pay. One suggestion was to allocate costs to citizens throughout the watershed.

### Relationship Between Standards and Research

It was noted that standards drive basic research and this role should be recognized. Some suggested areas for scientific inquiry include:

- the availability of non-point source nutrients to aquatic plants;
- the long-term effects on aquatic systems of controlling a single nutrient;
- trophic changes and the food chain; and
- field studies on various non-point source controls.

Goals for research should be set along with the standards.

### **Relationship Between Standards and Implementation**

Members were unanimous that just setting standards would not be enough. The legislative impetus for setting standards and developing an implementation program provides the state with an opportunity to make significant contributions in the area of nutrient management. Once standards have been set, management programs -- additional monitoring, waste load allocation, permit review, voluntary or mandatory BMP's -- must be developed where problems exist, and then revised as needed to achieve maximum effectiveness.

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